NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

WARTIME REPORT

ORIGINALLY ISSUED

July 1943 as
Memorandum Report

WATER TOLERANCE OF AVIATION GASOLINE CONTAINING XYLIDINES

By Joseph Revilock and Walter T. Olson

Aircraft Engine Research Laboratory
Cleveland, Ohio

NACA

WASHINGTON

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

MEMORANDUM REPORT

WATER TOLERANCE OF AVIATION GASOLINE CONTAINING XYLIDINES

By Joseph Revilock and Walter T. Olson

SUMMARY

Investigations were made to determine the effect of xylidines on the saturation concentration of water in aviation gasoline. The saturation concentration of water in gasoline containing 0, 1, and 3 percent xylidines was determined analytically using fresh water at 40° and 100° F and using sea water at 40° F. Both aromatic-free grade 65 gasoline and grade 65 gasoline containing 20 percent added aromatics were used. The water tolerance of grade 130 fuel containing 0, 1, and 3 percent xylidines was also determined according to this specification instead of the analytical method used for all other fuel samples.

These results indicated that no appreciable difference in the saturation concentration of water in gasoline was caused by the presence of xylidines for both nonaromatic and aromatic gasoline, for both fresh and sea water, and for both 40° and 100° F. It was concluded that xylidines may be added to aviation gasoline in quantities up to 3 percent by weight without appreciably increasing the solubility of water in the fuel for either fresh or salt water and over the range of temperatures likely to be experienced in storage.

INTRODUCTION

The work covered by this report presents the effect of xylidines on the saturation concentration of water in aviation gasoline and is part of a series of tests requested by the Army Air Forces to determine the suitability of xylidines as an added antiknock component in aircraft-engine fuel.

The water concentrations at saturation in aviation gasolines containing 0, 1, and 3 percent xylidines were determined analytically using both fresh and sea water. The effect of temperature and the effect of added aromatics on the water content were investigated. Also, the water tolerance of a grade 130 fuel containing 0, 1, and 3 percent by weight of xylidines was determined according to this specification instead of the analytical methods used for all the other fuel samples.

The water content of aviation gasoline is of importance inasmuch as the presence of excessive water dissolved in the fuel may, at low temperatures, lead to ice plugging of fuel screens.

The investigation was conducted at the Aircraft Engine Research Laboratory, Cleveland, Ohio, during June 1943, at the request of the Army Air Forces.

TEST SPECIMENS AND PROCEDURE

Samples. - Test samples consisting of 0, 1, and 3 percent by weight of xylidines (table I) were prepared in the following fuels:

(a) Grade 65 (specification AN-VV-F-756, Amendment-2) with aromatic hydrocarbons extracted by passage over silica gel.

(b) Grade 65 as delivered to which was added 20 percent by volume of an aromatic mixture consisting of 5 parts xylene, 2 parts cumene, and 1 part toluene. The grade 65 fuel as delivered was a clear gasoline and contained approximately 3 percent aromatics, which were essentially 2 parts toluene and 1 part benzene.

(c) Grade 130 (specification AN-F-28, Amendment-1).

TABLE I. - PROPERTIES OF XYLIDINES

A.S.T.M. distillation, $^{\circ}F$	
First drop	320
10 percent	408
30 percent	409
50 percent	410
70 percent	410
90 percent	410
End point	415
Specific gravity, 25° C/4° C	0.972
Refractive index n_D at 25° C	1.5597
Flash point (open cup), $^{\circ}F$	205

Procedure. - The gasoline samples were saturated with water by agitating 300 milliliters of gasoline for one-half hour with an equal volume of water in a constant-temperature bath. Samples were prepared with fresh water at 40° F and 100° F and for sea water at 40° F. At the end of the agitation period the layers were allowed to separate for 10 minutes in the bath. In the case of the 40° F determinations the gasoline layer was siphoned into a dry bottle which was at 40° F; for the 100° F determinations 20-milliliter samples were pipetted directly into the analyzing flasks.

Water tolerance by specification AN-F-28, December 23, 1942 was performed for the grade 130 fuel with 0, 1, and 3 percent xylidines. This test consists of shaking 80 milliliters of fuel with 20 milliliters of water and observing the change, if any, in the volume of either phase.

ANALYSIS

The method of Smith and Bryant was used (reference 1). Exactly 20-milliliter gasoline samples were treated with an acetyl chloride pyridine complex. One mole acetic acid was released for every mole of water present in the gasoline. The acetic acid was determined titrimetrically with approximately 0.1 N sodium hydroxide. Milligrams of water per milliliter of gasoline were calculated from the following equation:

$$\frac{\text{mgms of } H_2O}{\text{ml of gasoline}} = \frac{(\text{ml NaOH})\ (\text{normality NaOH})\ (\text{mol. wt. } H_2O)}{(\text{ml of sample})\ (0.975)}$$

The method has been shown to be only 97-98 percent stoichiometric, which accounts for the value of 0.975 in the equation.

RESULTS AND DISCUSSION

Table II lists the saturation concentration of water in the gasoline samples. Smith and Bryant claim that the sensitivity of the analytical method is 2 milligrams of water per 10 grams of sample (reference 1). The differences in table II are almost all smaller than this value.

TABLE II. - SATURATION CONCENTRATION OF WATER IN GASOLINE IN MILLIGRAMS PER CUBIC CENTIMETER OF GASOLINE

		Grade 65, aromatic free			Grade 65 as delivered plus 20 percent mixed aromatics[a]		
Xylidines, percent →		0	1	3	0	1	3
Fresh water	100° F	0.15	0.17	0.17	0.21	0.21	0.22
	40° F	0.07	0.10	0.03	0.14	0.11	0.08
Sea water	40° F	0.11	0.05	0.02	0.10	0.07	0.09

[a]Mixed aromatics consisted of 5 parts xylene, 2 parts cumene, and 1 part toluene.

Grade 130 fuel containing 0, 1, and 3 percent xylidines passed the Army specification that the fuel "shall be substantially immiscible with water" when tested by Federal Method 325.1.

Aircraft Engine Research Laboratory,
National Advisory Committee for Aeronautics,
Cleveland, Ohio, July 1, 1943.

REFERENCE

1. Smith, Donald Milton, and Bryant, W. M. D.: Titrimetric Determination of Water in Organic Liquids Using Acetyl Chloride and Pyridine. Jour. Am. Chem. Soc., vol. 57, no. 5, May 1935, pp. 841-845.